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3-24-08
Date

Joanne Bourguignon

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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| Applicants | : | Joseph H. Steinmetz et al. |
| Application No. | : | 10/702,137 |
| Filed | : | November 4, 2003 |
| For | : | Integrated-Circuit Implementation Of A Storage-Shelf Router And A Path Controller Card For Combined Use In High-Availability Mass-Storage-Device Shelves And That Support Virtual Disk Formatting |

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| Examiner | : | Woo H. Choi |
| Art Unit | : | 2189 |
| Docket No. | : | 35022.001C2 |
| Date : | | March 24, 2008 |

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**ATTENTION: Board of Patent Appeals and Interferences**

APPEAL BRIEF TRANSMITTAL

Sir:

Transmitted herewith, is the Appeal Brief in this application, with respect to the Notice of Appeal filed on January 23, 2008. The Commissioner is hereby authorized to charge the fee of $510 for filing this Appeal Brief to Deposit Account No. 50-2976.

Application believes that no extension of time is required. However, this conditional petition is being made to provide for the possibility that applicant has inadvertently overlooked the need for a petition and fee for extension of time.

The Commissioner is hereby authorized to charge any fees in conjunction with this communication or to credit any overpayment to Deposit Account No. 50-2976. At anytime during the pendency of this application, please charge any fees required or credit any overpayment to Deposit Account No. 50-2976 pursuant to 37 CFR 1.25. Additionally, please charge any fees to Deposit Account No. 50-2976 under 37 CFR 1.16 through 1.21 inclusive,

and any other sections in Title 37 of the Code of Federal Regulations that may regulate fees. This notice is being submitted in duplicate.

Respectfully submitted,
Joseph H. Steinmetz et al.
OLYMPIC PATENT WORKS PLLC

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Registration No. 39,906

Enclosures:
- Postcard
- Appeal Brief
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application of:

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## APPEAL BRIEF

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P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This appeal is from the decision of the Examiner, in an Office Action mailed August 22, 2007, finally rejecting claims 1-20.

## REAL PARTY IN INTEREST

The real party in interest is Sierra Logic a Delaware Corporation and having a principal place of business at 9083 Foothills Blvd., Suite 300, Roseville, California 95747, U.S.A.



## RELATED APPEALS AND INTERFERENCES

Applicant's representative has not identified, and does not know of, any other appeals of interferences which will directly affect or be directly affected by or have a bearing

on the Board's decision in the pending appeal.

## STATUS OF CLAIMS

Claims 1-20 are pending in the application. Claims 1-20 were rejected in the Office Action dated August 22, 2007. Applicants' appeal the final rejection of claims 1-20 which are copied in the attached CLAIMS APPENDIX.

## STATUS OF AMENDMENTS

No Amendment is enclosed with this brief. The last Amendment was filed June 8, 2007.

## SUMMARY OF CLAIMED SUBJECT MATTER

### Independent Claim 1

Claim 1 is directed to a virtual disk formatting system (Current Application, page 66, lines 4-17; Figures 37A-D; Current Application, page 68, line 6 - page 69, line 22) comprising: (1) a plurality of mass-storage devices (910-917 in Figure 9), each having physical sectors of a first sector length (Current Application, page 67, lines 5-6); and (2) a routing component (906 in Figure 9) that provides a virtual disk interface (Current Application, page 76, lines 3-17) to the mass-storage devices by routing each access operation, received from an external entity (902 in Figure 9), each access operation directed to a virtual disk (3702 in Figure 37A) having virtual sectors of a second sector length (Current Application, page 67, lines 13-14; page 68, lines 8-12), to one or more mass-storage devices of the plurality of mass-storage devices, having physical sectors of the first sector length, wherein the first sector length and the second sector length refer to data-payload lengths of physical sectors (Current Application, page 67, lines 5-6 and 13-14; Figures 36A-B, Figures 37A-D).

### Dependent Claims 2-6

Claim 2 is directed to the virtual disk formatting system of claim 1 wherein the routing component is an integrated-circuit storage-shelf router (Current Application, page 67, lines 24-26). Claim 3 is directed to the virtual disk formatting system of claim 2 wherein the storage-shelf router provides a fibre-channel-disk-based virtual disk formatting interface to

external entities (902 in Figure 9) and maps fibre-channel-disk-based access operations to a number of ATA disk drives (910-917) included in a storage shelf containing the storage-shelf router. Claim 4 is directed to the virtual disk formatting system of claim 1 wherein the routing component includes a processor and firmware/software programs (Current Application, page 40, lines 11-21; 1512 in Figure 15) that carry out virtual disk formatting. Claim 5 is directed to the virtual disk formatting system of claim 1 wherein virtual sectors are mapped onto contiguous physical sectors, allowing the physical sector and byte address of the first byte of a virtual sector to be calculated, when the second sector length is greater than the first sector length, as (Current Application, page 73, line 16 - page 75, line 4):

$$\text{fsl} = \text{first sector length}$$
$$\text{ssl} = \text{second sector length}$$
$$\text{modulus} = (\text{smallest number evenly divisible by both fsl and ssl}) / \text{ssl}$$
$$\text{difference} = \text{ssl} - \text{fsl}$$
$$\text{physical sector} = \text{virtual sector} + \left(\frac{\text{virtual sector}}{\text{modulus}}\right)$$
$$\text{physical byte address} = \text{remainder}\left(\frac{\text{virtual sector}}{\text{modulus}}\right) \times \text{difference}$$

and, when the second sector length is less than the first sector the physical sector and byte address of the first byte of a virtual sector is calculated, as:

$$\text{fsl} = \text{first sector length}$$
$$\text{ssl} = \text{second sector length}$$
$$\text{modulus} = (\text{smallest number evenly divisible by both fsl and ssl}) / \text{ssl}$$
$$\text{difference} = \text{fsl} - \text{ssl}$$
$$\text{physical sector} = \text{virtual sector} - \left(\frac{\text{virtual sector}}{\text{modulus}}\right)$$
$$\text{physical byte address} = \text{remainder}\left(\text{fsl} - \text{remainder}\left(\frac{\text{virtual sector}}{\text{modulus}}\right) \times \text{difference}\right) / \text{fsl}.$$

Claim 6 is directed to the virtual disk formatting system of claim 5 wherein, when the modulus and difference are both evenly divided by 2, the division and multiplication operations can be replaced with shift operations, and the remainder operation can be replaced by a bit-wise and operation (Current Application, page 73, line 16 - page 75, line 4).

Independent Claim 7

Claim 7 is directed to a virtual disk formatting system (Current Application, page 66, lines 4-17; Figures 37A-D; Current Application, page 68, line 6 - page 69, line 22) comprising: (1) a plurality of mass-storage devices (910-917 in Figure 9) having physical sectors of a first sector length (Current Application, page 67, lines 5-6); and (2) a routing component (906 in Figure 9) that provides to external entities (902 in Figure 9) a first virtual disk interface (Current Application, page 76, lines 3-17) to the mass-storage components by mapping each access operations, received from one of the external entities, directed to the first virtual disk interface having virtual sectors of a second sector length (Current Application, page 67, lines 13-14; page 68, lines 8-12) to an internal, virtual disk interface with internal-virtual-disk-sectors having a third sector length larger than the second sector length, and then routing the access operations from the internal, virtual disk interface to one or more mass-storage devices of the plurality of mass-storage devices, wherein the first sector length and the second sector length refer to data-payload lengths of physical sectors (Current Application, page 67, lines 5-6 and 13-14; Figures 36A-B, Figures 37A-D).

Dependent Claims 8-12

Claim 8 is directed to a virtual disk formatting system of claim 7 wherein the routing component includes error detection information within the internal-virtual-disk-interface sectors in order to provide routing-component-mediated error checking (Current Application, page 77, line 11 - page 81, line 12). Claim 9 is directed to the virtual disk formatting system of claim 8 wherein the error detection information is a longitudinal redundancy check code (Current Application, page 77, line 11 - page 81, line 12). Claim 10 is directed to the virtual disk formatting system of claim 7 wherein the routing component is an integrated-circuit storage-shelf router (Current Application, page 67, lines 24-26). Claim 11 is directed to the virtual disk formatting system of claim 10 wherein the storage-shelf router provides a fibre-channel-disk-based virtual disk formatting interface (Current Application, page 76, lines 3-17) to external processing entities (902 in Figure 9) and maps fibre-channel-disk-based access operations to a number of ATA disk drives (910-917 in Figure 9) included in a storage shelf containing the storage-shelf router. Claim 12 is directed to the virtual routing system of claim 7 wherein the routing component includes a processor and firmware/software programs (Current Application, page 40, lines 11-21; 1512 in Figure 15) that carry out virtual disk formatting.

Independent Claim 13

Claim 13 is directed to a method for providing a virtual-disk-format interface (Current Application, page 66, lines 4-17; Figures 37A-D; Current Application, page 68, line 6 - page 69, line 22) to processing entities external to a plurality of mass storage devices, each having physical sectors of a first sector length (Current Application, page 67, lines 5-6), the method comprising: (1) providing a routing component (906 in Figure 9); and (2) routing each access operation, received from an external entity (902 in Figure 9), each access operation directed to a virtual disk (3702 in Figure 37A) having virtual sectors of a second sector length (Current Application, page 67, lines 13-14; page 68, lines 8-12) by the routing component to one or more of the plurality of mass-storage devices having physical sectors of the first sector length (Current Application, page 67, lines 5-6), wherein the first sector length and the second sector length refer to data-payload lengths of physical sectors (Current Application, page 67, lines 5-6 and 13-14; Figures 36A-B, Figures 37A-D).

Dependent Claims 14-18

Claim 14 is directed to the method of claim 13 wherein the routing component is an integrated-circuit storage-shelf router (Current Application, page 67, lines 24-26). Claim 15 is directed to the method of claim 14 wherein the storage-shelf router provides a fibre-channel-disk-based virtual disk formatting interface (Current Application, page 76, lines 3-17) to external processing entities (902 in Figure 9) and further including: routing, by the storage-shelf router, fibre-channel-disk-based access operations to a number of ATA disk drives (910-917 in Figure 9) included in a storage shelf containing the storage-shelf router. Claim 16 is directed to the method of claim 13 wherein the routing component includes a processor and firmware/software programs (Current Application, page 40, lines 11-21; 1512 in Figure 15) that carry out virtual disk formatting. Claim 17 is directed to the method of claim 13 further including mapping, by the routing component, virtual sectors onto contiguous physical sectors, allowing the physical sector and byte address of the first byte of a virtual sector to be calculated, when the second sector length is greater than the first sector length, as (Current Application, page 73, line 16 - page 75, line 4):

$$\text{fsl} = \text{first sector length}$$
$$\text{ssl} = \text{second sector length}$$
$$\text{modulus} = (\text{smallest number evenly divisible by both fsl and ssl}) / \text{ssl}$$
$$\text{difference} = \text{ssl} - \text{fsl}$$
$$\text{physical sector} = \text{virtual sector} + \left(\frac{\text{virtual sector}}{\text{modulus}}\right)$$
$$\text{physical byte address} = \text{remainder}\left(\frac{\text{virtual sector}}{\text{modulus}}\right) \times \text{difference}$$

and, when the second sector length is less than the first sector the physical sector and byte address of the first byte of a virtual sector is calculated, as:

$$\text{fsl} = \text{first sector length}$$
$$\text{ssl} = \text{second sector length}$$
$$\text{modulus} = (\text{smallest number evenly divisible by both fsl and ssl}) / \text{ssl}$$
$$\text{difference} = \text{fsl} - \text{ssl}$$
$$\text{physical sector} = \text{virtual sector} - \left(\frac{\text{virtual sector}}{\text{modulus}}\right)$$
$$\text{physical byte address} = \text{remainder}\left(\text{fsl} - \text{remainder}\left(\frac{\text{virtual sector}}{\text{modulus}}\right) \times \text{difference}\right) / \text{fsl}.$$

Claim 18 is directed to the method of claim 17 wherein, when the modulus and difference are both evenly divided by 2, the division and multiplication operations can be replaced with shift operations, and the remainder operation can be replaced by a bit-wise and operation (Current Application, page 73, line 16 - page 75, line 4).

## Independent Claim 19

Claim 19 is directed to a method (Current Application, page 76, line 13 - page 77, line 10) for including additional information in disk sectors of a plurality of mass-storage devices (910-917 in Figure 9) having a first sector length (Current Application, page 67, lines 5-6), the method comprising : (1) providing a routing component (906 in Figure 9); (2) mapping, by the routing component, access operations, received from one of the external entities (902 in Figure 9), directed to a first virtual disk interface (Current Application, page 76, lines 3-17) having virtual sectors of a second sector length (Current Application, page 67, lines 13-14; page 68, lines 8-12) to an internal, virtual disk interface with internal-virtual-disk-sectors having a third sector length larger than the second sector length, and then

routing, by the routing component, the access operations from the internal, virtual disk interface to one or more of the plurality of mass-storage devices, wherein the first sector length and the second sector length refer to data-payload lengths of physical sectors (Current Application, page 67, lines 5-6 and 13-14; Figures 36A-B, Figures 37A-D).

Dependent Claim 20

Claim 20 is directed to the method of claim 19 wherein the routing component includes within the internal-virtual-disk-interface sectors, one of: (1) error-detection information; (2) additional information that, together with the data contained in the internal-virtual-disk-interface sectors, provides an encrypted version of the data directed to the first virtual disk interface by external processing entities; and (3) error-detection and error-correction information (Current Application, page 77, line 11 - page 81, line 12).

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

1. The rejection of claims 1-20 under 35 U.S.C. §112, first paragraph.

2. The rejection of claims 1-20 under 35 U.S.C. §112, second paragraph.

3. The rejections of claims 1, 4-6, 13, and 16-18 under 35 U.S.C. §102(b) as being anticipated by Colligan, U.S. Patent Application Publication No. 2002/0065982 ("Colligan").

4. The rejection of claims 1, 13, 7, 8, 12, 19, and 20 under 35 U.S.C. §102(b) as being anticipated by Manka, U.S. Patent No. 5,072,378 ("Manka").

5. The rejection of claims 2, 13, 14, and 15 under 35 U.S.C. §103(a) as being unpatentable over Colligan in view of Sanada et al., U.S. Patent Application Publication No. 2002/0083285 ("Sanada").

6. The rejection of claims 2, 3, 10, 11, 14, and 15 under 35 U.S.C. §103(a) as being unpatentable over Manka in view of Sanada and further in view of Surugucchi, U.S.

Patent No. 6,928,509 ("Surugucchi").

ARGUMENT

Claims 1-20 are pending in the current application. Claims 1-20 were initially rejected in an office action issued November 3, 2005. Claims 1-20 were again rejected in an office action issued June 27, 2006. Claims 1-20 were finally rejected in an office action issued March 8, 2007. A request for continuing examination was filed on June 8, 2007, and, in response, the Examiner rejected claims 1-20 in an office action issued August 22, 2007 ("Office Action"). Appellants respectfully traverse all of the rejections of claims 1-20.

**ISSUE 1**

1. The rejection of claims 1-20 under 35 U.S.C. §112, first paragraph.

In rejecting claims 1-20 under 35 U.S.C. §112, first paragraph, the Examiner states:

> The specification does not seem to describe a virtual disk having virtual sectors of a second sector length wherein the second sector length refers to data payload lengths of physical sectors. According to paragraph 174 (PGPUB No. 2004/0148461) of the published application, 520-byte virtual sector seems to be a logical sector. The specification does not seem to disclose that this logical sector refers to data payload of a physical sector. The specification does not disclose how this logical/virtual sector is related to a physical sector of any kind.

This point has been discussed and explained many times during prosecution of the current application. The Examiner appears to have a very difficult time understanding basic disk technologies. In order to assist the Examiner in understanding the current invention, Appellants' representative, in a response filed on November 27, 2006, included a significant amount of basic information on the layout of hard disks and terminology associated with disks. However, despite these efforts, the Examiner appears to continue to have problems with understanding basic disk drive technology.

As has been explained many times, and as is explained in the current application, the sectors of magnetic disk platters that are accessed by disk drives contain both data payload, essentially the data that can be written to, and read from, a sector by a disk-drive-accessing entity or device, as well as additional information, such as a sector number

and error-detection and error-correction information. This additional information is generally placed in the sector, maintained, and updated by the disk-drive controller, and is not generally accessible to external entities and devices that access the data through the disk-drive controller. As is well known to anyone even cursorily familiar with disk-drive technology, the length of sectors discussed in technical documents, specifications, and other documents related to disk drives and disk-drive technologies, are the lengths of the data payload portion of sectors. As has been pointed out multiple times by Appellants' representative, the current application explains this point on line 5 of page 67:

> In ATA disk drives, as illustrated in Figure 36A, each sector of each track generally contains a data payload of 512 bytes. The sectors contain additional information, including a sector number and error-detection and error-correction information. This additional information is generally maintained and used by the disk-drive controller, and may not be externally accessible. This additional information is not relevant to the current invention. Therefore, sectors will be discussed with respect to the number of bytes of data payload included in the sectors.

Further down, on the same page of the current application, one virtual-disk-formatting embodiment of the present invention is discussed, in overview, beginning on line 24 of page 67, as follows:

> The storage-shelf router that, in various embodiments, is the subject of the present invention allows economical ATA disk drives to be employed within storage shelves of a fiber-channel-based disk array. However, certain currently available FC-based controllers may be implemented to interface exclusively with disk drives supporting 520-byte sectors. Although the manufacturer of an ATA or SATA-based storage shelf may elect to require currently-non-ATA-compatible disk-array controllers to be enhanced in order to interface to 512-byte-sector-containing ATA or SATA disk drives, a more feasible approach is to implement storage-shelf routers to support virtual disk formatting. ***Virtual disk formatting provides, to external entities such as disk-array controllers, the illusion of a storage shelf containing disk drives formatted to the FC-disk-drive, 520-byte-sector formatting convention, with the storage-shelf router or storage-shelf routers within the storage shelf handling the mapping of 520-byte-sector-based disk-access commands to the 512-byte-sector formatting employed by the ATA disk drives within the storage shelf.*** (emphasis added)

Thus, virtual formatting allows, in the described embodiment, a disk-array controller to access what the disk-array controller assumes to be 520-byte FC-disk-drive sectors, even though the virtual formatting method of the present invention stores data on, and retrieves data from, 512-byte ATA-disk-drive sectors. Both numbers refer to the data payload within

sectors of the FC disks and ATA disks.

Appellants' representative has explained repeatedly, and in great detail, to what the phrase "virtual disk formatting" refers, and the fact that sectors are traditionally described in terms of the length of the data payloads within physical sectors. Claim 1 and the remaining claims in the current application include language to make explicit and clear that sector lengths referred to in the claims refer to data-payload lengths of physical sectors. In other words, considering claim 1, when the claimed virtual disk formatting system virtualizes 520-byte FC-disk-drive sectors to 512-byte ATA-disk-drive sectors, as described in the above-quoted paragraph, the first sector length of the physical sectors of mass-storage devices, recited in the first element of claim 1, is 512 bytes, and the second sector length of the virtual sectors, recited in the second element of claim 1, is 520 bytes. Appellants' representative cannot think of a more clear and direct way of claiming the fact that the virtual disk formatting system virtualizes mass-storage devices having sectors of a first length so that these mass-storage devices can be accessed, through the virtual disk formatting system, as if they contain sectors of a second sector length. The virtual sectors appear to external, accessing entities, such as disk-array controllers, as physical sectors of a different type of mass-storage device with a different physical-sector length, namely, the second sector length.

The current application describes, in great detail, how virtual sectors are mapped to physical sectors in a variety of embodiments of the present invention. All of the figures which illustrate this mapping, beginning with Figure 37A, and including Figure 44, to which the Examiner refers, include sector lengths or imply sector lengths that are, as clearly stated in the first quoted passage of the current application, above, the lengths of the data-payload portions of physical sectors. Thus, as clearly stated in the above-quoted passage of the current application, sector lengths, both physical and virtual, refer to the lengths of the data-payload portions of physical sectors.

Again, to be clear, and again considering claim 1, the physical sectors of the mass-storage devices have a first sector length. According to the last portion of claim 1, this first sector length refers to the data-payload lengths of physical sectors, in this case the physical sectors of the mass-storage devices. External entities access these mass-storage devices through the virtual-disk interface, recited in the second element of claim 1, by access operations directed to virtual disks having virtual sectors of a second sector length. The second sector length, according to the last clause in claim 1, refers to the data-payload length of physical sectors, namely, the physical sectors of the type of disk that the mass-storage

devices appear to be through the virtual interface. Thus, if the virtual disk is an FC disk with 520-byte sectors, then the second sector length is 520 bytes. In the above-discussed application of the current invention, ATA disks are virtualized to appear as FC disks. FC disks have 520-byte sectors, where the length 520 refers to the data payload portion of FC-disk sectors.

In Appellants' representative's respectfully offered opinion, claim 1, and the other claims of the current application, are readily understandable by anyone even cursorily familiar with mass-storage devices, basic computer science, basic electrical engineering, or any of a variety of related fields. While the fact that the lengths of disk sectors that are referred to by those skilled in the art are the lengths of the data-payload portions of sectors, and not the full, physical length of the sectors, may be confusing to those unfamiliar with mass-storage devices and computer science, anyone cursorily familiar with such devices and with basic computer science well understands that a 520-byte FC-disk-drive sector contains 520 bytes of data that can be written and read by external entities, such as operating systems or disk-array-control programs executing on remote computers. No one familiar with mass-storage devices and basic computer science would assume that the actual, physical length of a 520-byte FC-disk-drive sector is 520 bytes, since anyone familiar with disk-drive, disk-array, and mass-storage device technologies understands that physical sectors contain additional data that is generally accessible only to the disk-drive controller, and is not generally accessible to external, accessing entities. If this is not understood by the Examiner, after multiple responses, at least one of which includes detailed explanatory information about disk drives and magnetic-disk formats, then Appellants' representative respectfully suggests that the current application should be transferred to another art group more familiar with computer science, computer hardware, and mass-storage devices.

Appellants' representative notes that, in M.P.E.P. §706(II), the M.P.E.P. expresses what Applicants' representative believes to be the proper, constructive role of an examiner:

> When an application discloses patentable subject matter and it is apparent from the claims and the applicants' arguments that the claims are intended to be directed to such patentable subject matter, but the claims in their present form cannot be allowed because of defects in form or omission of a limitation, the examiner should not stop with a bare objection or rejection of the claims. The examiner's actions should be constructive in nature and when possible should offer a definite suggestion for correction.

Throughout the prosecution of the current application, it appears that the Examiner, rather than undertaking to carefully read and understand the current application, and without attempting to understand the current claims in context of the current application, instead simply rejects the claims without offering any constructive suggestion for alternative claim language that the Examiner would find acceptable. In Appellants' representative's respectfully offered opinion, if the Examiner cannot understand to what the current claims are directed, based on the prosecution history and the current application, then the current application should be examined in another art group. If the Examiner does understand that to which the current claims are directed, then, in Appellants' representative's respectfully offered opinion, rather than continuing to summarily reject every attempt made by Appellants to claim the current invention in a way that is acceptable to the Examiner, the Examiner should provide suggestions for claim language that the Examiner would find acceptable. Again, in the current case, Appellants' representative believes that the claims clearly describe Appellants' invention – namely, the virtual disk formatting system described in the current application.

**ISSUE 2**

2. The rejection of claims 1-20 under 35 U.S.C. §112, second paragraph.

Hopefully, this issue has been addressed in arguments provided in the previous subsection. A virtual disk is, as discussed above, an interface to mass-storage devices of one type that allows external, accessing entities to access the mass-storage devices as if those devices were mass-storage devices of a second type. Sectors, whether virtual or physical, have a length. That length is, as discussed above, and as discussed multiple times in prosecution of the current application, generally understood to be the length of the data-payload portion of physical sectors on the data-storage medium of a disk. Thus, in the above-discussed example, a virtual FC-disk drive has virtual sectors of length 520 bytes, since the data payload portion of FC-disk physical sectors is 520 bytes. Appellants' representative can find nothing at all unclear or indefinite in the claim language referring to virtual disks having virtual sectors of a second length, wherein the second length refers to data payload lengths of physical sectors. This claim language exactly states to what the specified sizes, or lengths, of virtual sectors refer.

**ISSUE 3**

3. The rejection of claims 1, 4-6, 13, and 16-18 under 35 U.S.C. §102(b) as being anticipated by Colligan.

Colligan has been previously discussed during prosecution of the current application. Colligan does not teach, mention, or suggest a virtual interface to a plurality of mass-storage devices.

First, consider claim 1 of the current application:

> 1. A virtual disk formatting system comprising:
> a plurality of mass-storage devices, each having physical sectors of a first sector length; and
> a routing component that provides a virtual disk interface to the mass-storage devices by routing each access operation, received from an external entity, each access operation directed to a virtual disk having virtual sectors of a second sector length, to one or more mass-storage devices of the plurality of mass-storage devices, having physical sectors of the first sector length;
> wherein the first sector length and the second sector length refer to data-payload lengths of physical sectors.

Note that claim 1 recites, as the first element of a virtual-disk formatting system, "a plurality of mass-storage devices, each having physical sectors of a first sector length." Thus, the claimed virtual disk formatting system includes at least two mass-storage devices that share a common physical sector size. Claim 1 additionally claims "a routing component that provides a virtual disk interface to the mass-storage devices." In other words, the routing component, a component separate from the mass-storage devices, provides a single virtual-disk interface to multiple mass-storage devices — namely, the "plurality of mass-storage devices" recited in the first element of claim 1. Note that the routing component forwards access operations received from an external entity; in other words, from an entity external to the routing component and external to the plurality of mass-storage devices, directed to a virtual disk with virtual sectors of a second sector length, to one or more of the mass-storage devices which have physical sectors of a first sector length. In other words, as clearly claimed in claim 1, the routing component provides a virtual disk interface on behalf of external entities, which access the plurality of mass-storage devices as if the plurality of mass-storage devices were one or more virtual disks with a sector length different from the sector length of the plurality of mass-storage devices. As claimed in claim 2, and as discussed in the current application at length, one embodiment of the virtual disk formatting

system claimed in claim 1 is implemented in a storage-shelf router within a disk array. Figure 9 of the current application illustrates the position of a storage-shelf router (906 in Figure 9) between a disk-array controller 902 and a number of mass-storage devices 910-917. The disk-array controller 902 is an external entity that directs accesses to a virtual disk through a virtual disk interface provided by the storage-shelf router 906. As discussed in the paragraph quoted in the first subsection of this appeal brief, an application of the present invention is to allow 512-byte-sector ATA disk drives to be included in a disk array in which the disk-array controller assumes the disks to be 520-byte FC disk drives.

According to MPEP § 2131, a cited reference ***must*** teach each and every claim limitation to serve as the basis of a valid 35 U.S.C. § 102 rejection:

> *"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference."* Verdegaal Bros. v. Union Oil Co. of California, *814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987)*

As discussed below, Colligan does not teach many of the limitations of claims 1 and the dependent claims that depend from them.

Turning to Colligan, which has been previously discussed in detail during prosecution of the current application, Colligan is directed to formatting data-storage media in order to match data transmission rates. As an aside, beginning in paragraph [0044] on page 4 of Colligan, Colligan describes what Colligan refers to as "an adaptive hard disk drive cache" that allows an I/O controller (175 in Figure 1 of Colligan) to transmit 1024-byte data packets to a hard disk drive formatted for 512-byte sectors. This is accomplished, in the hard disk drive cache, by rearranging 512-byte chunks of data read from the data-storage medium so that the hard disk drive can return pairs of 512-byte data chunks back to the I/O controller as if the hard disk drive were formatted to have 1024-byte sectors. The I/O controller (175 in Figure 1 of Colligan) is considered, by the Examiner, to be the routing component of claim 1. The routing component of claim 1 provides a virtual disk format to external entities. By contrast, as clearly stated by Colligan, Colligan's "adaptive hard disk drive cache" is implemented within a hard disk drive, which the Examiner considers to be a mass-storage device, so that the I/O controller, or routing component, according to the Examiner, can receive 1024-byte packets from the hard disk drive, rather than 512-byte packets. Thus, were Colligan's "adaptive hard disk drive cache" considered to be a virtual disk interface, it would

be provided by a mass-storage device, in Colligan, rather than the routing component, as claimed in claim 1. Second, and equally importantly, claim 1 claims a routing component that provides a virtual disk interface to multiple mass-storage devices. As can be clearly understood by anyone remotely familiar with computer hardware and computer science, Colligan's "adaptive hard disk drive cache" is contained within a single mass-storage device. The Examiner apparently assumes, in the statement of rejection, that the floppy drive (185 in Figure 1 of Colligan) and the hard drive (180 in Figure 1 of Colligan) both have identically sized sectors. Nothing in Colligan states, mentions, or even remotely suggests this to be the case. Claim 1 specifically and explicitly claims that the second sector length of the virtual disk refers to the data-payload length of a physical sector. By contrast, the sizes of packets transmitted to, and received from, the hard disk drive by Colligan's I/O controller are communications-medium data-packet sizes are related to the data-transmission rate of the communications medium by which Colligan's I/O controller communicates with the hard disk drive, as mentioned even in the abstract of Colligan, and not physical sector sizes. Thus, as can hopefully be appreciated, claim 1 of the current application does not read on Colligan's "adaptive hard disk drive cache."

Of course, anyone who has thoroughly read the current application well understands that the invention to which the current claims are directed has nothing at all to do with data caches within individual mass-storage devices. The features of claim 1, discussed in this subsection, are not coincidental or inadvertent. A virtual disk interface provided by a routing component to a plurality of mass-storage devices is a far more complex and fundamental computational entity than the simple reordering of data chunks stored in a hard-disk-drive cache by a disk-drive controller, as anyone even cursorily familiar with computer science well understands. For example, because a virtual disk may encompass multiple mass-storage devices, a routing component, such as that to which claim 1 is directed, must truly route access operations among multiple mass-storage devices, according to the types of calculations discussed in the current application for determining in which mass-storage device a given virtual sector resides. By contrast, Colligan's I/O controller routes all hard-disk-drive accesses to Colligan's hard disk drive, and routes all floppy-disk access operations to Colligan's floppy disk drive. Because there is no virtual disk interface in Colligan that spans multiple mass-storage devices, there is no need, in Colligan, for the complex routing considerations discussed in the current application. Colligan also depends on the various communications-medium data-packet sizes to be exact multiples of one another; otherwise,

simple reordering of data chunks in cache memory would not be a sufficient and viable strategy for allowing the I/O controller to send data packets with a different amount of data than contained in each sector of the hard disk drive.

Again, to summarize, claim 1 claims a virtual disk interface provided by a routing component, external to a plurality of mass-storage devices, to external entities that access the mass-storage devices. Thus, the virtual interface conceptually lies between the routing component and external entities that access the mass-storage devices, in the currently claimed invention. By contrast, Colligan discusses a cache-reordering scheme that allows an I/O controller, which the Examiner considers to be a routing component, to transmit data packets of sizes different from sector sizes to a hard disk drive. In other words, a limited virtual interface provided in Colligan's system lies between a mass-storage device and router, and is not provided by the router to external entities that access the hard-disk drive. The currently claimed virtual formatting system provides a single virtual disk interface to a plurality of mass-storage devices. By contrast, a single mass-storage device in Colligan's system provides a very limited virtual interface to a single I/O controller. Colligan does not teach, mention, or in any way suggest the currently claimed invention, because, as noted above, a simple data-chunk reordering scheme within the memory cache of a disk drive cannot provide a virtual disk interface to multiple disk drives.

Claims 5-6 and 17-18 contain detailed calculations of mapping of virtual sectors to physical sectors in the claimed virtual disk formatting system and method for providing a virtual-disk-format interface. The Examiner has utterly failed to point to any similar calculation in Colligan. Instead, the Examiner states that "there is no evidence to suggest that address calculation as claimed is prohibited" in Colligan. This is a ridiculous rejection. As the Examiner should hopefully understand, in order to reject a claim under 35 U.S.C. §102, the cited reference must teach or disclose each and every element of the claim. It is not sufficient for a cited reference to not prohibit the elements of a claim. By the Examiner's reasoning, any reference that does not specifically prohibit virtual-to-physical calculations claimed in claims 5-6 and 17-18 would anticipate claims 5-6 and 17-18. By this reasoning, for example, an issued patent directed to automobile transmissions, which does not mention mass-storage devices, virtual sectors, and physical sectors, would not prohibit calculations such as those claimed in claims 5-6 and 17-18, and therefore would anticipate claims 5-6 and 17-18. This type of rejection contradicts the basic principles of patent examination and claim rejection.

**ISSUE 4**

4. The rejection of claims 1, 13, 7, 8, 12, 19, and 20 under 35 U.S.C. §102(b) as being anticipated by Manka.

In rejecting claims 1 and 3, the Examiner refers to the entire Figure 2 of Manka as teaching the claimed routing component. Figure 2 of Manka includes a CPU, a main storage or memory, and a channel unit of a mainframe computer, as well as a disk control unit and a number of logical device unit controllers. The Examiner has utterly failed, in the rejection of claims 1 and 13, to point with any kind of specificity to a single component of Manka's mainframe computer that constitutes the claimed routing component. This rejection is flawed for falling well below the standards for adequate specificity in rejecting claims, as discussed in M.P.E.P. §§ 2106(VII) and 2125:

> **CLEARLY COMMUNICATE FINDINGS, CONCLUSIONS AND THEIR BASES**
>
> Once USPTO personnel have concluded the above analyses of the claimed invention under all the statutory provisions, including 35 U.S.C. 101, 112, 102and 103, they should review all the proposed rejections and their bases to confirm that they are able to set forth a *prima facie* case of unpatentability. Only then should any rejection be imposed in an Office action. The Office action should clearly communicate the findings, conclusions and reasons which support them."
>
> **DRAWINGS CAN BE USED AS PRIOR ART**
>
> Drawings and pictures can anticipate claims if they clearly show the structure which is claimed. *In re Mraz*, 455 F.2d 1069, 173 USPQ 25 (CCPA 1972). However, the picture must show all the claimed structural features and how they are put together. *Jockmus v. Leviton*, 28 F.2d 812 (2d Cir. 1928). ... The drawings must be evaluated for what they reasonably disclose and suggest to one of ordinary skill in the art. *In re Aslanian*, 590 F.2d 911, 200 USPQ 500 (CCPA 1979).

Appellants' representative is left to guess which part of a complicated mainframe computer system the Examiner feels the routing-component element of claims 1 and 13 to read on. Appellants' representative requests the Appeal Board to find this rejection insufficiently specific, under the clearly stated standards of M.P.E.P. §2106. Manka's Figure 2 contains no component labeled or otherwise indicated to be a routing component. The Examiner has pointed to no component. An entire mainframe computer system is not a routing component.

Moreover, Figure 2 shows absolutely no detail or information concerning a virtual disk interface, which Appellants' claimed routing component provides.

Manka states, beginning on the last line of column 7 and extending to the second line of column 8, that components 100-106 of the prior-art, conventional mainframe computer are identical to components 100-106 of Manka's modified mainframe system. Thus, it would seem that none of these components would be likely candidates onto which Appellants' claimed routing component can be read, although, again, lacking any specific clues from the rejection, Appellants' representative cannot say for sure. Manka's logical disk unit controllers, such as logical disk unit controller 209-0 of Figure 2, are clearly not routing components. As described beginning on line 59 of column 7 of Manka, these logical disk unit controllers carry out a parallel data transfer of any given virtual track to all of the physical disk units, such as physical disk unit 211-0 in Figure 2, simultaneously, with each of the physical disk units rotationally synchronized. Thus, the logical disk unit controller does not route access operations to one or more physical devices, as claimed in claims 1 and 13 of the current application. Instead, it simply disassembles the virtual track into *n* components, where *n* is the number of physical disk units, and carries out a simultaneous, parallel access operation to all of the *n* physical disk units. This is not routing. Routing involves selecting one or more target devices from among a larger number of candidate target devices. For example, the routing component of a communications network routes incoming packets to target nodes within a system generally containing many hundreds of potential target nodes. Were the component to simply pass any incoming messages to a predefined set of nodes to which the component is connected, as is the case for Manka's logical disk unit controller, it would not be a router. The proper technical terms might include "fan-out device" or "demultiplexer." A router necessarily makes routing decisions. Manka's logical disk unit controller, by contrast, makes no routing decisions, identically disassembling any received virtual track into a fixed number of virtual-track components, each of which is predefined to reside in a particular physical disk unit.

The rejections of claims 7, 12, and 19 fail for the same reason the rejections of claims 1 and 13 fail. Again, the Examiner points to a high-level block diagram of an entire mainframe computer system as teaching the claimed routing component. Appellants' representative does not see a routing component in that diagram, and cannot guess, from the Examiner's rejections, which component the Examiner views as a routing component.

**ISSUE 5**

5. The rejection of claims 2, 13, 14, and 15 under 35 U.S.C. §103(a) as being unpatentable over Colligan in view of Sanada.

According to MPEP § 2143:

> **ESTABLISHING A *PRIMA FACIE* CASE OF OBVIOUSNESS**
> The key to supporting any rejection under 35 U.S.C. 103 is the clear articulation of the reason(s) why the claimed invention would have been obvious. The Supreme Court in *KSR International Co. v. Teleflex Inc.*, 550 U.S. ___, ___, 82 USPQ2d 1385, 1396 **2143** MANUAL OF PATENT EXAMINING PROCEDURE Rev. 6, Sept. 2007 2100-128 (2007) noted that the analysis supporting a rejection under 35 U.S.C. 103 should be made explicit. The Federal Circuit has stated that "***rejections on obviousness cannot be sustained with mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness***." *In re Kahn*, 441 F.3d 977, 988, 78 USPQ2d 1329, 1336 (Fed. Cir. 2006). See also *KSR*, 550 U.S. at ___ , 82 USPQ2d at 1396 (quoting Federal Circuit statement with approval). (emphasis added)

In rejecting claims 2, 13, 14, and 15, the Examiner states that "Colligan discloses all of the limitations of the parent claims as discussed above." Colligan does not. In fact, as discussed above, Colligan is essentially unrelated to the claimed invention. Colligan simply discloses a memory cache within a hard disk drive that can reorder chunks of memory in order to accept and return larger data packets containing more data than contained in the sectors of the hard disk. The Examiner combines Colligan, essentially unrelated to the current claims and current application, with Figure 1 of Sanada, suggesting that anyone ordinarily skilled in the art could combine a high-level block diagram of a disk array that interfaces to host computers through a fiber channel, represented as a single oval node in Figure 1, with Colligan to reproduce the currently claimed invention. This rejection is absurd, entirely conclusory, and irrational. The best engineer cannot transform an oval node in a high-level block diagram labeled "fiber channel fabric" and, possibly, a square node labeled "fiber channel control unit" into a virtual disk interface. Sanada has nothing at all to do with virtual disk interfaces, and Colligan does not teach, mention, or suggest a virtual disk interface as claimed by Appellants. Perhaps the Examiner is unaware that communications systems and media, such as the fiber channel, employ protocols with specific types of frames that correspond to various types of high-level commands. Such frames would need to be processed by hardware and/or firmware components and translated into ATA or SATA commands, for example. Neither a simple, oval-shaped node nor a rectangular-shaped node in a block diagram obviously teaches, mentions, or suggests such details, or anything else of

use to an implementer of a virtual disk interface.

According to MPEP § 2143.03(A)(II):

**All Claim Limitations Must Be Considered**

> "All words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970). If an independent claim is nonobvious under 35 U.S.C. 103, then any claim depending therefrom is nonobvious. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988).

Claim 2 of the current application claims a routing component that is "an integrated-circuit storage-shelf router." Nothing in any of the cited references is even remotely related to a single integrated-circuit implementation of a storage-shelf router. Of course, the Examiner has failed to even attempt to point to an integrated-circuit implementation of anything in the cited references.

This rejection falls far below the standards for a 35 U.S.C. §103 obviousness-type rejection. Oval and rectangular shapes in block diagrams teach nothing of substance, as anyone even remotely familiar with any engineering discipline well understands. There is no justification for the Examiner's assertion that an oval shaped node in a high-level block diagram would point even a skilled inventor to anything that could be combined with Colligan to suggest or make obvious the currently claimed invention.

**ISSUE 6**

6. <u>The rejection of claims 2, 3, 10, 11, 14, and 15 under 35 U.S.C. §103(a) as being unpatentable over Manka in view of Sanada and further in view of Surugucchi</u>.

This rejection is to similar to the rejection discussed in the previous subsection, and, like that rejection, is completely unfounded and absurd. The Examiner cites five lines in column 1 of Surugucchi that, according to the Examiner, combined with Manka and Sanada, would enable one skilled in the art to obtain the currently claimed invention. This cited portion of Surugucchi reads almost like the introductory sentence of a marketing brochure:

> Serial ATA (S-ATA) is intended to become the dominant interface for the desktop disk drive market. With its cost advantages and the ability to hot plug devices, S-ATA also provides great value for servers and redundant array of inexpensive disks (RAID) applications.

Clearly, these four lines do not teach, mention, or even remotely suggest any technical details regarding ATA or SATA. Again, the Examiner's rejection is completely conclusory, as discussed in MPEP § 2143, without providing any justification why an oval-shaped node combined with two non-technical marketing-pamphlet-like statements enables anyone to draw any conclusions or inferences about anything. In fact, the recited statements suggest that SATA is a future development, rather than currently available. As discussed in previous section of this appeal brief, Manka and Sanada fail to teach, mention, or suggest the currently claimed invention. To suggest that the above-quoted sentence can somehow provide the teaching or suggestion of claimed subject matter that is lacking in Manka and Sanada is absurd. Hot pluggability and "great value" do not have anything to do with virtual disk interfaces.

The Examiner, again, has failed to even consider many of the limitations of the claims. For example, claim 2 claims that the routing component is "an integrated-circuit storage-shelf router." The Examiner has failed to point to anything in any of the cited references that is implemented as an integrated-circuit, let alone a storage-shelf router. According to MPEP § 2143.03(A)(II):

> **All Claim Limitations Must Be Considered**
>
> "All words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970). If an independent claim is nonobvious under 35 U.S.C. 103, then any claim depending therefrom is nonobvious. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988).

Thus, this rejection, as true of the previously discussed rejections, fails to consider many claim elements and show how those claim elements are taught or suggested in the cited references.

## CONCLUSION

In summary, the Examiner has completely failed to present a legitimate rejection of any of the current claims. Colligan is clearly unrelated to the currently claimed invention. Colligan simply discloses a memory-chunk reordering scheme within the cache memory of a disk-drive controller which, as discussed above, is not related to the currently claimed virtual disk interface, and which would be completely inadequate to implement a

virtual disk interface, as claimed in the current application. With regard to Manka, the Examiner points to a block diagram of an entire mainframe computer system as teaching the routing component claimed in the current claims. This is obviously completely inadequate, in specificity, for a claim rejection. Appellants' representative can find no routing component in the diagram, and the Examiner has failed to point to one. The Examiner cites a simple, high-level block diagram of Sanada and four lines of Surugucchi that read as if they were taken from a marketing brochure. These citations are absurd. They provide no technical information, and nothing useful to one of ordinary skill in the art with regard to implementing or practicing the claimed invention.

Appellants have spent a significant amount of time and a very significant amount of money attempting to prosecute the current application. Appellants deserve a chance to respond to clearly articulated and legitimate claim rejections, if related references can be found on which to base such rejections. Otherwise, Appellants deserve to have their claims issued. The careless and unfounded rejections traversed in this appeal brief are a waste of the Appellants' time and money, and a waste of the U.S.P.T.O.'s time and money. When considerable effort has been made by the courts and the U.S.P.T.O. to provide reasonable standards for examination, examiners should adhere to those standards.

Appellants respectfully submit that all statutory requirements are met and that the present application is allowable over all the references of record. Therefore, Appellants respectfully request that the present application be passed to issue.

Respectfully submitted,
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## CLAIMS APPENDIX

1. A virtual disk formatting system comprising:

a plurality of mass-storage devices, each having physical sectors of a first sector length; and

a routing component that provides a virtual disk interface to the mass-storage devices by routing each access operation, received from an external entity, each access operation directed to a virtual disk having virtual sectors of a second sector length, to one or more mass-storage devices of the plurality of mass-storage devices, having physical sectors of the first sector length;

wherein the first sector length and the second sector length refer to data-payload lengths of physical sectors.

2. The virtual disk formatting system of claim 1 wherein the routing component is an integrated-circuit storage-shelf router.

3. The virtual disk formatting system of claim 2 wherein the storage-shelf router provides a fibre-channel-disk-based virtual disk formatting interface to external entities and maps fibre-channel-disk-based access operations to a number of ATA disk drives included in a storage shelf containing the storage-shelf router.

4. The virtual disk formatting system of claim 1 wherein the routing component includes a processor and firmware/software programs that carry out virtual disk formatting.

5. The virtual disk formatting system of claim 1 wherein virtual sectors are mapped onto contiguous physical sectors, allowing the physical sector and byte address of the first byte of a virtual sector to be calculated, when the second sector length is greater than the first sector length, as:

$$\text{fsl} = \text{first sector length}$$
$$\text{ssl} = \text{second sector length}$$
$$\text{modulus} = (\text{smallest number evenly divisible by both fsl and ssl}) / \text{ssl}$$
$$\text{difference} = \text{ssl - fsl}$$
$$\text{physical sector} = \text{virtual sector} + \left(\frac{\text{virtual sector}}{\text{modulus}}\right)$$
$$\text{physical byte address} = \text{remainder}\left(\frac{\text{virtual sector}}{\text{modulus}}\right) \times \text{difference}$$

and, when the second sector length is less than the first sector the physical sector and byte address of the first byte of a virtual sector is calculated, as:

$$\text{fsl} = \text{first sector length}$$
$$\text{ssl} = \text{second sector length}$$
$$\text{modulus} = (\text{smallest number evenly divisible by both fsl and ssl}) / \text{ssl}$$
$$\text{difference} = \text{fsl} - \text{ssl}$$
$$\text{physical sector} = \text{virtual sector} - \left(\frac{\text{virtual sector}}{\text{modulus}}\right)$$
$$\text{physical byte address} = \text{remainder}\left(\text{fsl} - \text{remainder}\left(\frac{\text{virtual sector}}{\text{modulus}}\right) \times \text{difference}\right) / \text{fsl}.$$

6. The virtual disk formatting system of claim 5 wherein, when the modulus and difference are both evenly divided by 2, the division and multiplication operations can be replaced with shift operations, and the remainder operation can be replaced by a bit-wise and operation.

7. A virtual disk formatting system comprising:

a plurality of mass-storage devices having physical sectors of a first sector length; and

a routing component that provides to external entities a first virtual disk interface to the mass-storage components by mapping each access operations, received from one of the external entities, directed to the first virtual disk interface having virtual sectors of a second sector length to an internal, virtual disk interface with internal-virtual-disk-sectors having a third sector length larger than the second sector length, and then routing the access operations from the internal, virtual disk interface to one or more mass-storage devices of the plurality of mass-storage devices;

wherein the first sector length and the second sector length refer to data-payload lengths of physical sectors.

8. A virtual disk formatting system of claim 7 further including:

including, by the routing component, error detection information within the internal-virtual-disk-interface sectors in order to provide routing-component-mediated error checking.

9. The virtual disk formatting system of claim 8 wherein the error detection information is a longitudinal redundancy check code.

10. The virtual disk formatting system of claim 7 wherein the routing component is an integrated-circuit storage-shelf router.

11. The virtual disk formatting system of claim 10 wherein the storage-shelf router provides a fibre-channel-disk-based virtual disk formatting interface to external processing entities and maps fibre-channel-disk-based access operations to a number of ATA disk drives included in a storage shelf containing the storage-shelf router.

12. The virtual routing system of claim 7 wherein the routing component includes a processor and firmware/software programs that carry out virtual disk formatting.

13. A method for providing a virtual-disk-format interface to processing entities external to a plurality of mass storage devices, each having physical sectors of a first sector length, the method comprising:

providing a routing component; and

routing each access operation, received from an external entity, each access operation directed to a virtual disk having virtual sectors of a second sector length by the routing component to one or more of the plurality of mass-storage devices having physical sectors of the first sector length;

wherein the first sector length and the second sector length refer to data-payload lengths of physical sectors.

14. The method of claim 13 wherein the routing component is an integrated-circuit storage-shelf router.

15. The method of claim 14 wherein the storage-shelf router provides a fibre-channel-disk-based virtual disk formatting interface to external processing entities and further including:

routing, by the storage-shelf router, fibre-channel-disk-based access operations to a number of ATA disk drives included in a storage shelf containing the storage-shelf router.

16. The method of claim 13 wherein the routing component includes a processor and firmware/software programs that carry out virtual disk formatting.

17. The method of claim 13 further including:

mapping, by the routing component, virtual sectors onto contiguous physical sectors, allowing the physical sector and byte address of the first byte of a virtual sector to be calculated, when the second sector length is greater than the first sector length, as:

$$\text{fsl} = \text{first sector length}$$
$$\text{ssl} = \text{second sector length}$$
$$\text{modulus} = (\text{smallest number evenly divisible by both fsl and ssl}) / \text{ssl}$$
$$\text{difference} = \text{ssl - fsl}$$
$$\text{physical sector} = \text{virtual sector} + \left(\frac{\text{virtual sector}}{\text{modulus}}\right)$$
$$\text{physical byte address} = \text{remainder}\left(\frac{\text{virtual sector}}{\text{modulus}}\right) \times \text{difference}$$

and, when the second sector length is less than the first sector the physical sector and byte address of the first byte of a virtual sector is calculated, as:

$$\text{fsl} = \text{first sector length}$$
$$\text{ssl} = \text{second sector length}$$
$$\text{modulus} = (\text{smallest number evenly divisible by both fsl and ssl}) / \text{ssl}$$
$$\text{difference} = \text{fsl} - \text{ssl}$$
$$\text{physical sector} = \text{virtual sector} - \left(\frac{\text{virtual sector}}{\text{modulus}}\right)$$
$$\text{physical byte address} = \text{remainder}\left(\text{fsl} - \text{remainder}\left(\frac{\text{virtual sector}}{\text{modulus}}\right) \times \text{difference}\right) / \text{fsl}.$$

18. The method of claim 17 wherein, when the modulus and difference are both evenly divided by 2, the division and multiplication operations can be replaced with shift operations, and the remainder operation can be replaced by a bit-wise and operation.

19. A method for including additional information in disk sectors of a plurality of mass-storage devices having a first sector length, the method comprising :

providing a routing component;

mapping, by the routing component, access operations, received from one of the external entities, directed to a first virtual disk interface having virtual sectors of a second sector length to an internal, virtual disk interface with internal-virtual-disk-sectors having a third sector length larger than the second sector length, and then routing, by the routing component, the access operations from the internal, virtual disk interface to one or more of the plurality of mass-storage devices;

wherein the first sector length and the second sector length refer to data-payload lengths of physical sectors.

20. The method of claim 19 further including:

including, by the routing component, within the internal-virtual-disk-interface sectors one of:

error-detection information;

additional information that, together with the data contained in the internal-virtual-disk-interface sectors, provides an encrypted version of the data directed to the first virtual disk interface by external processing entities; and

error-detection and error-correction information.

## EVIDENCE APPENDIX

None.

# RELATED PROCEEDINGS APPENDIX

None.